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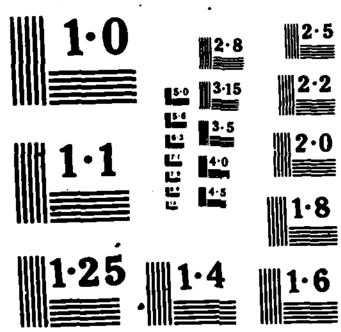


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# AIR COMMAND AND STAFF COLLEGE

## STUDENT REPORT

QUALITY SOUND:

A HANDBOOK FOR ADDITIONAL DUTY SOUND MEN

MAJOR H. BRUCE GILKES 86-0985

*"insights into tomorrow"*

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Contemporary musical performance by Air Force bands necessitates heavy reliance on amplified sound. Operation of sound equipment must be performed by Air Force musicians due to the lack of spaces for actual audio technicians. The handbook addresses Air Force band audio system design, problems, operation and troubleshooting in terms understandable by a non-technician. Its intent is to provide a foundation in audio system comprehension for Air Force bandsmen who serve as sound men as an additional duty.

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# PREFACE

The contemporary musical performance profession places great emphasis on electronics and amplified sound. By extension, the Air Force Band Program must also rely heavily on the same types of equipment used by the commercial world. Unlike commercial performing groups, however, Air Force bands must rely on band members rather than professional audio engineers to deal with sound equipment. This handbook is designed to establish a foundation for bandsmen who work with audio gear, but who lack technical expertise and experience. It is written in layman's terms in order to facilitate understanding as well as to provide a basic framework on which to build greater proficiency and knowledge.

The author thanks CMSgt Leo Henley, Superintendent, Air University Band, for his valuable assistance and expertise in preparing this handbook.

## ABOUT THE AUTHOR

Major H. Bruce Gilkes is a native of Massapequa Park, Long Island, New York, and entered the United States Air Force in 1965 as an instrumentalist with the United States Air Force Band, Washington, D.C. He later served there as Assistant Director of Tours while completing a Bachelor of Music Degree at the Catholic University of America, which he earned in 1973, magna cum laude. He received his commission that same year and returned to the United States Air Force Band as Operations Officer. In 1974, Major Gilkes was appointed Director, the Singing Sergeants, as well as Audio Officer for the U.S. Air Force Band. He subsequently became Commander, the Air Force Band of New England, Pease AFB, NH, in 1979. In 1981, he was appointed as Commander, the Air Force Band of the East, McGuire AFB, NJ, a position he held until 1985. Major Gilkes is a 1979 graduate of Squadron Officers School and earned a Master of Music Degree from the Catholic University of America in 1984. That same year, he also completed Air Command and Staff College by correspondence. Major Gilkes' decorations include the Meritorious Service Medal with oak leaf cluster, the Air Force Commendation Medal with oak leaf cluster and the Air Force Achievement Medal. In 1984, he was made a Jimmy Doolittle Fellow of the Air Force Association.

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Chapter One

# INTRODUCTION

## THE IMPORTANCE OF SOUND THAT WORKS

In today's world of sound gear, stereos, MTV, and entertainment, there is an increasing awareness and focus on audio quality. Although Air Force bands have been dealing in sound since their creation, today, the heavy reliance on electronics and reinforced sound or PA has placed greater demands on band personnel in order to keep sound systems operating. Add to this the responsibility to uphold a totally professional image along with the emphasis on technology in the modern Air Force, and sound men have greater impetus to make the system work every time. After all, to millions of Americans across the nation each year, an Air Force band is the only part of the Air Force they ever personally come in contact with.

With the intent of helping to maintain the professional image, this handbook has been compiled to assist bandsmen in understanding and operating sound systems.

## PURPOSE AND INTENT

The main purpose of this handbook is to explain some of the basic principles and procedures concerning sound systems in layman's terms. Tech manuals that come with equipment are great for those who understand them. They contain some of the particulars mentioned in later chapters. This booklet, however, is a practical approach, with some of the technical jargon reduced to a more general, basic knowledge level. Also incorporated into these chapters are actual beneficial experiences or problems encountered in the band system. Sharing these should be profitable, and many of them are probably recognizable.

This is not a handbook for the experienced audio technician although some ideas may be useful. It is for the budding sound man who needs to learn quickly and who has not had any firm foundation. In addition, the author has made no attempt to incorporate any ideas concerning musical judgment in audio mixing. This area is so subjective, individualized, and varies with the musical medium so much that it is impractical. It's rather akin to trying to describe an abstract painting to someone over the telephone. With the intended audience and purpose limited, an understanding of the conditions which prompted this handbook is warranted so that the reader may have an idea where Air Force band sound men have been and where they are going.

## NEEDS ASSESSMENT

Inasmuch as Air Force field bands are self-contained squadron structures, bandsmen are required to perform all of the functions normally handled by a squadron. It is mandated, however, that they be 35, 45, or 60-piece bands with no support slots authorized. Consequently, bandsmen perform non-musical functions as additional duties. The function of sound man, therefore, is filled by an individual who is one of the performers in the band.

During the last three world-wide Band Officers' and Superintendents' Conferences, the subject concerning sound men support slots surfaced. Additional slots have been ruled out. The career field has already undergone several cuts in strength; an increase is unrealistic. The possibility of creating an additional shred for a support person was broached, but rejected because of the enhancement that it would cause in promotions. The remaining choice is to use an existing musician or do without. In the current musical performance arena, doing without is not a viable option.

The performance media today center around light and sound. Most contemporary music is vocal in nature which requires amplification. The rock medium alone is a study in sound power and electronic instruments. Consequently, the way of Air Force bands is largely dictated by the commercial music world. Bands spend most of their resources selling the Air Force to recruitment-age young Americans. This is done through polished performances of the music which these potential Air Force members identify with, hence, the requirement for first rate audio.

Since band sound men transfer or separate as do other Air Force members, expertise in audio frequently leaves with the individuals. No continuity document or handbook has ever existed in the band program to educate others as to past mistakes or methods of operation. The intent of this handbook is to help fill that void.

According to the Chief, Air Force Bands and Music Branch (SAF/PACE), no relief is in sight which would alter the present method of operation. Therefore, to further develop bandsmen as additional duty sound men, and to provide a foundation for continuity and improved understanding and operation, this handbook is prepared in language that is informative but easily digestible.

## Chapter Two

# DESIGNING A ROAD SYSTEM

### A FAIL-SAFE SYSTEM

The fail-safe sound system for touring Air Force bands simply does not exist. In spite of the roadworthiness of many components and their ability to repeatedly perform successfully, road wear will eventually take its toll (19:—). By anticipating the likelihood of breakdown due to age and use, one can come closest to having a system which will perform whenever it is supposed to. Basically, therefore, the operator is the principal fail-safe mechanism in this type system since it is he who must project equipment failure. This facet of the operator's job will be much easier if simplicity is inherent in the system design.

### THE IMPORTANCE OF SIMPLICITY

In the Air Force band environment, where performance set-up time is usually constrained, simplicity of system design can save the day. While sophistication of equipment is taken for granted in the audio industry, ultra-sophistication in system design may simplistically be translated into more toys to break. If only one bandsman can understand the ins and outs of the system and it is conceived as an audiophile's dream (at least one knob or switch for everything), then the designer did not take a realistic approach and consider the true operational environment for that system. The system must be understandable (27:—).

To enhance the understandability of the system, logic and common sense must be applied from the outset. For systems already in existence, it would pay to take the time to reorganize power racks, effects racks, cable harnesses, etc., if the resulting change would simplify the operation and increase the comprehension factor for future operators. Equipment in racks should be organized logically as should snake use. The author has found repeatedly that this pays great dividends when it is ten minutes before downbeat and one component in the chain of equipment fails. The operator will be able to find and eliminate the culprit much more readily if he does not have to figure out what leads to what under a time-pressure situation. The following information provides more specific guidance in system structure and use.

## Chapter Three

## A SAMPLE QUALITY ROAD SYSTEM

Perhaps a cardinal rule about sound systems, whether home or professional, is that they are as good as the piece of junk in the line. That is, when a string of components is assembled, the system can only function as well as the weakest piece of equipment. As with any type gear, you get what you pay for, and mixing Cadillac and VW parts will not net Cadillac performance in the end. That is not to say that every system for Air Force bands should be the absolute top of the line model. Equipment should be matched to the requirements of the particular mission. In terms of performance, reliability, and maintainability, however, top notch equipment is a must (19:--; 27:--). Both the Air Force professional image and dollars are preserved in the long run with this philosophy. A look at major component parts will permit more exacting comments.

### SOUND MIXING BOARD

An exceptionally large number of mixing consoles exists on the market today. Choosing the correct one is a two phase process. First, the operator must identify exactly what the sound board must be able to do (24:--). Secondly, the operator must find a quality board that can perform the desired functions, be maintainable, reliable and affordable (27:--). Unused features are wasted dollars, therefore, it is critical to identify requirements beforehand, then find the board which meets the need. Points to consider are:

Number of inputs
Flexibility of inputs (mic and line level)
Number of echo sends per channel (for effects)
Number of monitor sends per channel
Compatibility of connectors to rest of equipment
Is power supply external or integrated
Weight - board must truly be portable
Solo/cue feature (isolate one or more channels in headphones)
Input signal indicators (LED's--light-emitting diodes)
Peak input indicators (LED's)
Output level indicators for mains, effects and monitors
Ease of operation
Reliability reputation and availability of service
Do commercial touring groups use the board
Built in pink noise generator
Submaster assignment flexibility (to group vocals, etc.)

There are certainly others, but this list encompasses the basics (24:--; 27:--).

The sound mixing board provides the "master control" for audio reinforcement, however, much additional enhancement is also available. Both to improve the amplified sound and minimize feedback problems, the graphic equalizer is indispensable to live audio reinforcement (27:--).

## EQUALIZATION

An equalizer may best be thought of as a set of multiple tone controls (21:35). Just as the generic treble and bass controls enhance home reproduced sound, the graphic equalizer adjusts the sound of the signal in the system (21:35). The graphic equalizer, however, is much more selective and specific and therefore affects the sound in narrower groups of frequencies than do normal bass and treble controls (21:35). This is an invaluable asset to the traveling Air Force Band. Since bands must contend with different room acoustics as much as three times a day, adjustments must be available to make the system sound as good as possible in each location. The graphic equalizer, in part, has that capability (15:27).

Equalizers come in various shapes and sizes. The author finds that the sophistication of the 1/3-octave graphic equalizer offers the greatest flexibility for adjustment to changing performance conditions (15:--). The 1/3-octave simply means that each octave of sound is divided into three parts, and the frequency window of each third can be independently affected by its own control. This is particularly handy when seeking to eliminate feedback since the equalizer allows the operator to zero in on the troublesome frequency area without affecting those frequency groups on either side of it (15:27). Less sophisticated one octave or 1/2-octave equalizers affect broader groups of frequencies (more notes) with their controls and therefore do not offer the selectivity that 1/3-octave units provide (14:33). For traveling audio reinforcement systems, therefore, the more selective 1/3-octave graphic equalizer is most practical.

How does the operator know what the correct arrangement of frequency adjustments is on the graphic equalizer? The least expensive means is by using the ear and musical common sense. This is a trial and error method, though, and takes much time while the operator plays with each frequency control. On the other hand, efficient use of the graphic equalizer can be made easy when used in conjuction with an audio spectrum analyzer (14:36).

## AUDIO SPECTRUM ANALYZER

Well worth the investment, a real time audio spectrum analyzer will save much time and anguish on the road during set up when time is chronically limited. Basically, this instrument gives the operator an illuminated graphic representation of the audio spectrum in the room in real time, that is, as it happens. Used in conjunction with the graphic equalizer, the analyzer can

assist the operator in "hearing" what the room sounds like as well as in identifying those culprit frequencies that want to make a solo appearance as feedback. Since the operator can see the room's frequency response on the analyzer, he can immediately make adjustments to the graphic equalizer and, in turn, see those adjustments graphically represented on the analyzer. The sound used to perform this task is called pink noise, and comes from a pink noise generator.

Resembling the sound of heavy wind and rain on a tin roof, pink noise is an even cross-section of frequencies covering the entire hearing range. By feeding this through the audio reinforcement system, the operator fills the room with a sampling of all frequencies. This is an unpleasant, irritating noise and consequently must be used without the public present. Inasmuch as each room has its own peculiar acoustical characteristics, the room will either increase or decrease the intensity of certain frequencies. The spectrum analyzer shows the operator exactly how the room is affecting the spectrum of frequencies, thereby identifying which frequencies are strengthened or weakened. The operator may then even out these peaks and valleys using the graphic equalizer to electronically counterbalance the natural acoustical tendencies of the room (15:28). Using the equalizer and analyzer together is infinitely faster than ear and equalizer alone. It must be said, however, that the ear remains the final judge as to whether or not the system sounds right, and the sound quality must ultimately be balanced using a known quantity such as a live vocalist and/or a familiar high quality tape. The electronic devices quicken the process, the human ear refines it.

This process for "tuning" the room is applicable both for the main system for the audience as well as for the monitor system on stage. Each system must be adjusted separately. There will, therefore, be an independent equalizer setting for the main system and most likely a different curve on the equalizer used for the monitors on stage. Once these systems have been "EQ'd" or equalized, there remains the task of minimizing feedback.

With proper use of equipment, feedback can almost be eliminated (15:27-28; 27:—). After the previous process is completed, it is time to "ring" the hall. This is accomplished by running up the volume on microphones until the system feeds back. This must be done with caution so as not to destroy speakers with a sudden roaring howl. As the tone feeds back, once again the spectrum analyzer will identify the frequency zone and the equalizer may be used to take out that problem frequency zone. This is again accomplished separately for both the monitor system and the main system. The end result, except for the most miserable of circumstances, will be a good size volume capability (15:28). This should allow vocalists or soloists to be heard above the band without the embarrassment of feedback (27:—).

Whereas the combination of equalizer and analyzer improve the quality of amplified sound for both the audience and performer, another device is invaluable for its ability to deal more with the quantity of sound being amplified.

## COMPRESSOR/LIMITER

The compressor/limiter serves two very basic purposes in live performance. It protects the audience and the sound system when used properly. This unit allows the operator to establish an electronic "ceiling" for volume. It limits the signal coming out of the unit, compressing everything above the ceiling down to that ceiling level (4:18,48). In other words, it puts a lid on volume. This results in the two-fold protection.

Sudden bursts of sound from a vocalist, for instance, cause a surge of power to go through the system. This surge can both damage expensive speaker parts or cause considerable ear pain to the audience (10:173; 23:22). Both money and image, perhaps even liability, are at stake here. Replacement titanium alloy diaphragms for 2" horn drivers cost approximately $110.00 each. Although replacement is inevitable, a compressor/limiter in the line lengthens diaphragm life by many performances thereby reducing cost of spares (23:24). On the audience's side it is a matter of comfort or environmental health (10:172-173).

With younger audiences tending toward louder experiences in sound, there is a responsible role to be played by the sound system operator: protection of the audience from excessive volume. The compressor/limiter can be used to contain the sound system volume within reasonable boundaries. Obviously, on stage volume must be prudently controlled by the performers themselves. The sound man, however, should cap the maximum volume from the system.

To put levels of sound in perspective it is best to look at a cross section of known sound experiences (8:29-31). Levels are measured in decibels (db) in a relative scale (1:102; 9:289-297). That is, there is no absolute 0 db (5:606). Live performances in concert halls can reach 95-100 db during brief peaks (18:—). Rock concerts go considerably higher, reaching levels of 130 db which is 10,000 times the 90 db sound level allowable for long-term noise in factories (18:—). Figure 1 provides a useful scale to see where different sounds fit.

Using the compressor/limiter, the operator can ensure that loud sound levels are kept in check without constantly tinkering with the main volume control. In any event, the electronics in this unit can handle unexpected surges better than the human hand can. For general sound level measurement, the audio spectrum analyzer previously discussed usually has a db measurement feature which can register the volume right on the spot. This information, coupled with good judgment, should lead to adequate sound with minimum equipment damage and audience complaints.

Up to this point, the basic signal has been discussed, a signal which is at a very low voltage. To ultimately drive the speaker system which fills the area with sound this low voltage must be magnified many times (1:126). This magnification, of course, occurs in the power amplifiers.

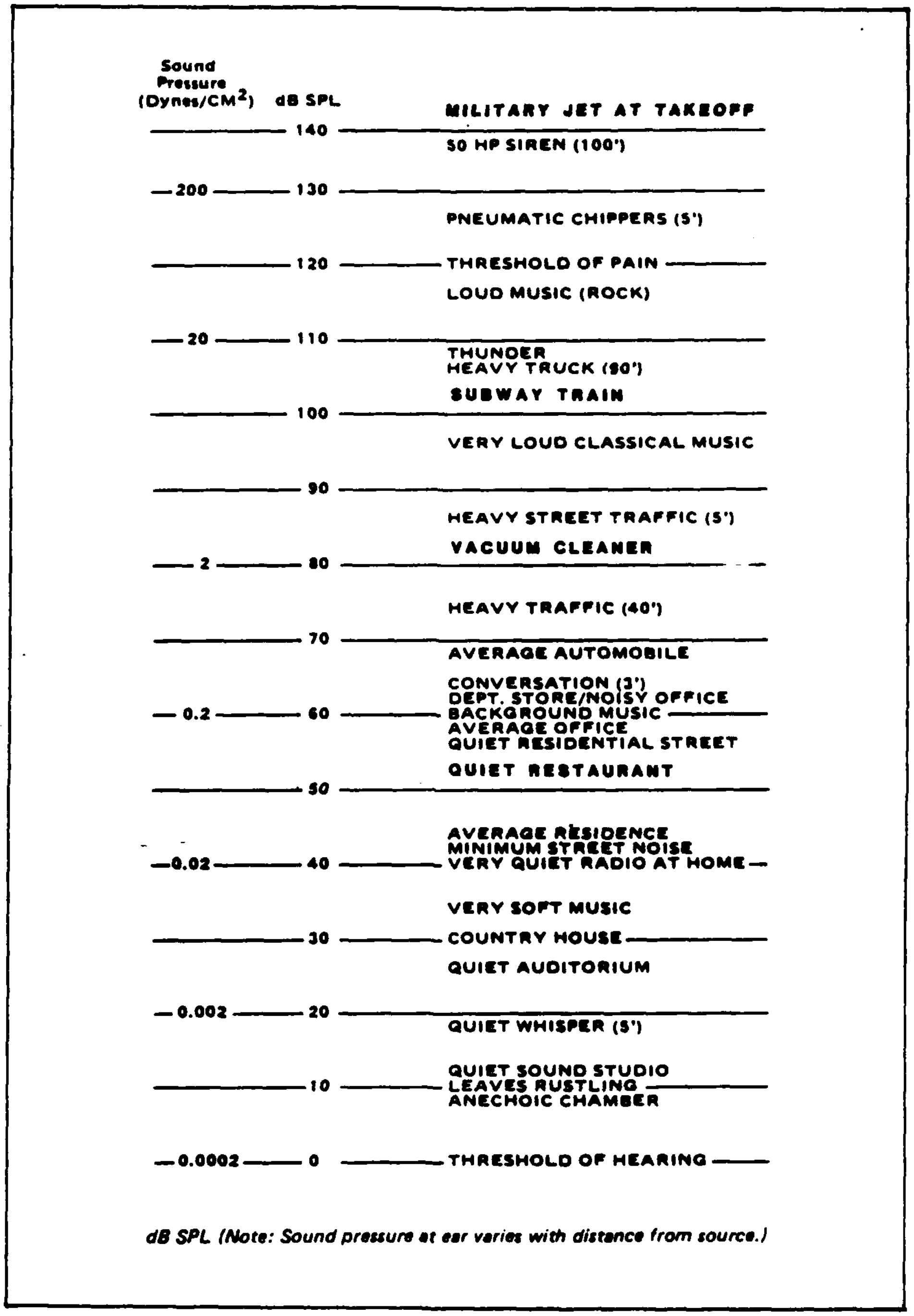


Figure 1. Sound Level Chart (4:23; 10:173)

## POWER AMPLIFIERS

An amp is not an amp -- they are not equal. Many power amps are available commercially and they come in many sizes. Of critical concern, however, is that the amps be suited to the speakers they are to drive and that they are designed to offer some built-in protection, both for the amps and for the speakers (23:—). To begin, suitability or matching is an easy enough task to both understand and accomplish.

A 40 horsepower engine will not move a Lincoln Continental very well, but a V-8 supercharged engine will tear up a VW bug. The amplifier must be matched to its respective job (26:—). Low frequency woofers require more power than high frequency horns simply because low frequencies eat up more power making the speaker cone move to generate the sound. Higher frequencies generate less speaker movement and consequently require less energy to do the job (26:—). Recommended power requirements on each make of speaker are to be taken seriously with a penalty to pay if they are not. A smaller amplifier being overworked driving woofers will not only be unable to deliver enough power, it will eventually protest and stop delivering. On the other hand, an oversized amplifier with much power to spare, driving a horn that does not require much, may soon literally melt the coils on a costly diaphragm (23:23). These are problems easily avoided by careful planning and attention to detail. Additional problems can be avoided by buying amps with protection features inherent in their design (23:24).

Basic protection in amps includes thermal, input and output. Thermal is heat sensitive protection which shuts down the amp automatically before it overheats further and does costly damage to itself. Input protection concerns potential overloading of the amp. A "clipping" feature prohibits too much signal from being fed to the amp and is usually indicated by some LED indicator. At the output or speaker side of the amp, DC protection is found on quality amps (23:24). This feature simply disconnects the speakers if DC (direct current) suddenly flows through the circuit. Direct current to a speaker is the equivalent of capital punishment by electrocution -- no more speaker (23:24). Other features are also available, but those mentioned are key.

One very critical area which merits attention concerning power amps is impedance matching with speakers. Whatever impedance is indicated on the amp output, this is the minimum amount of impedance or resistance that the amp wants to "see" or be exposed to. Most amps are rated at 4 or 8 ohms (27:—). Because of flexibility, the lower impedance output is desirable. It permits up to three 16 ohm horns to be connected in parallel, whereas the 8 ohm rated amp would only permit two. The following equations are provided for computing the actual impedance of speaker groups. While they appear complicated, they are easily used with or without a calculator. $Z$ is the overall impedance wanted. $Z_1$, $Z_2$, $Z_3$ are the respective impedances of speakers 1, 2, 3. For two speakers:

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2} \qquad (7:14)$$

If $Z_1$ and $Z_2$ are 16 ohms each then

$$Z = \frac{16 \times 16}{16 + 16} = \frac{256}{32} = 8 \text{ ohms}$$

If $Z_1$ and $Z_2$ are 8 ohms each then $Z = 4$ ohms

For three speakers the equation is:

$$Z = \frac{Z_1 Z_2 Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_1 Z_3} \qquad (7:14)$$

If $Z_1$, $Z_2$ and $Z_3$ are 16 ohms each then

$$Z = \frac{16 \times 16 \times 16}{(16 \times 16) + (16 \times 16) + (16 \times 16)} = \frac{4096}{768} = 5.3 \text{ ohms}$$

If $Z_1$, $Z_2$ and $Z_3$ are 8 ohms each then

$$Z = \frac{8 \times 8 \times 8}{(8 \times 8) + (8 \times 8) + (8 \times 8)} = \frac{512}{192} = 2.6 \text{ ohms}$$

With an 8 ohm amp output, therefore, three 16 ohm speakers could not be used since the resulting speaker impedance is only 5.3 ohms. With a 4 ohm output, however, these speakers could be accommodated.

It is not important to get bogged down in the equations, but it is important to know how many of what speaker can be connected to what amp. Exceeding that number will usually eventually end up in silence. Therefore, it pays to double check impedances, compute if necessary, and write down the maximum combinations allowable. Both the quality of sound and the life of the amp will be prolonged.

Certainly the quality of equipment, the capability of the system and the skill and knowledge of the operator all have a part in the end product. There are some nuts and bolts ideas, however, which should also be factored into the sound system. They come under the umbrella of standardization.

## Chapter Four

## THE IMPORTANCE OF STANDARDIZATION

Effectiveness in training, maintenance and discipline is enhanced throughout the Air Force by attention to standardization. Extending this idea and applying it to audio reinforcement systems has positive implications which are very valuable. Negatively, not employing standardization can spell anything from annoyance to disaster. In any case, the entire subject is one of practicality.

### PRACTICAL APPLICATIONS BETWEEN UNIT SYSTEMS

Inasmuch as all Air Force bands have multiple performing groups and consequently multiple sound systems, standardization provides potential survivability (27:—). If different components, connectors, etc., are all compatible, then interchangeable elements exist between the band's different sound systems. Obviously there is a compatibility built into professional equipment design. There is, however, also a tendency toward unique characteristics in hookups, connectors, cable snakes, etc., in some systems, rendering them useless to another system without some sort of modification. On the other hand, standardization throughout a band's systems creates interoperability, making possible an easy "quick fix" while the main problem is repaired. In addition, operators of each system can more easily operate another on short notice without having to read a different rule book which probably does not exist anyway. Timely survival in sound can be improved on by examining standardization.

### STANDARD CONNECTORS

Looking at standardization can become item specific. Connectors are small items which can render big items useless. Quality XLR connectors for mic lines are a must as is a complete kit of adapters. Switchcraft has a complete line which should always be carried with the sound system. They are not used a great deal, but when they are needed, there is no timely substitute. Speaker connectors tend to vary more than any of the other connectors. The author has found that the twist-lock variety is extremely durable, remains secure when connected and offers better cable stress relief. It pays, however, to put the same connectors on all speakers so that all speakers and cables are usable with any system. One warning, ridiculous as it may seem: a standard 110-volt connector of any kind should never be used for speakers (23:24). Eventually someone will plug it into a wall socket and launch a speaker. It has been done.

## INDUSTRY STANDARD PHASING OR CONNECTIONS

In-house repairs of cables and connectors can easily lead to unique methods of wiring. To insure that all cables will work as they are supposed to, the audio industry has established the standard depicted in Figure 2. A copy of this diagram both in the repair shop and on the road should save both guess work and problems.

One caveat concerns the phasing of twist-lock speaker connectors. To avoid accidentally sending the bass speaker signal to the high frequency horns, which would destroy them, it is best to phase the connectors so that certain pairs of pins are used for each type speaker and for no other. With three pins or contacts, for instance, there are three possibilities for pairs, pins 1 and 2, 2 and 3, 1 and 3. This is a safeguard well worth the effort. In addition, proper phasing implies having the + and - sides of amplifiers and speakers the same throughout the system. If one set of speakers is wired in reverse, it will be out of phase with the other set. In simple terms, the speakers will not be moving in and out at the same time. The resulting sound of out-of-phase speakers is "cheap" sound (25:14). Frequencies cancel out one another and poor reproduction is the end product (25:14). Attached to connectors, properly phased, must be the proper cable.

## CABLES

Although it all looks very much alike, cable comes in volumes of types. The important point is that mic cables are for microphones, not speakers, and that lamp cord, called zip-cord, is for lamps, not speakers. Because of the use of phone plugs for both speakers and instrument hookups it is easy for coaxial cable (center strands with a braided shield around it) to be used for speaker hookups. This must be guarded against. There is a natural characteristic of coaxial cable that causes it to make the amp overwork. It was not intended for that kind of use and can stress the amp considerably.

Cable for speakers should be 16-gauge for most applications. Lamp cord is 18-gauge, has weak insulation, and eats up power rapidly in longer lengths. The larger 16-gauge can handle the power, and with a rubber or neoprene insulation, can withstand the wear and tear on the road. As with connectors and connections, the standard of the industry applied to cables will provide optimum service.

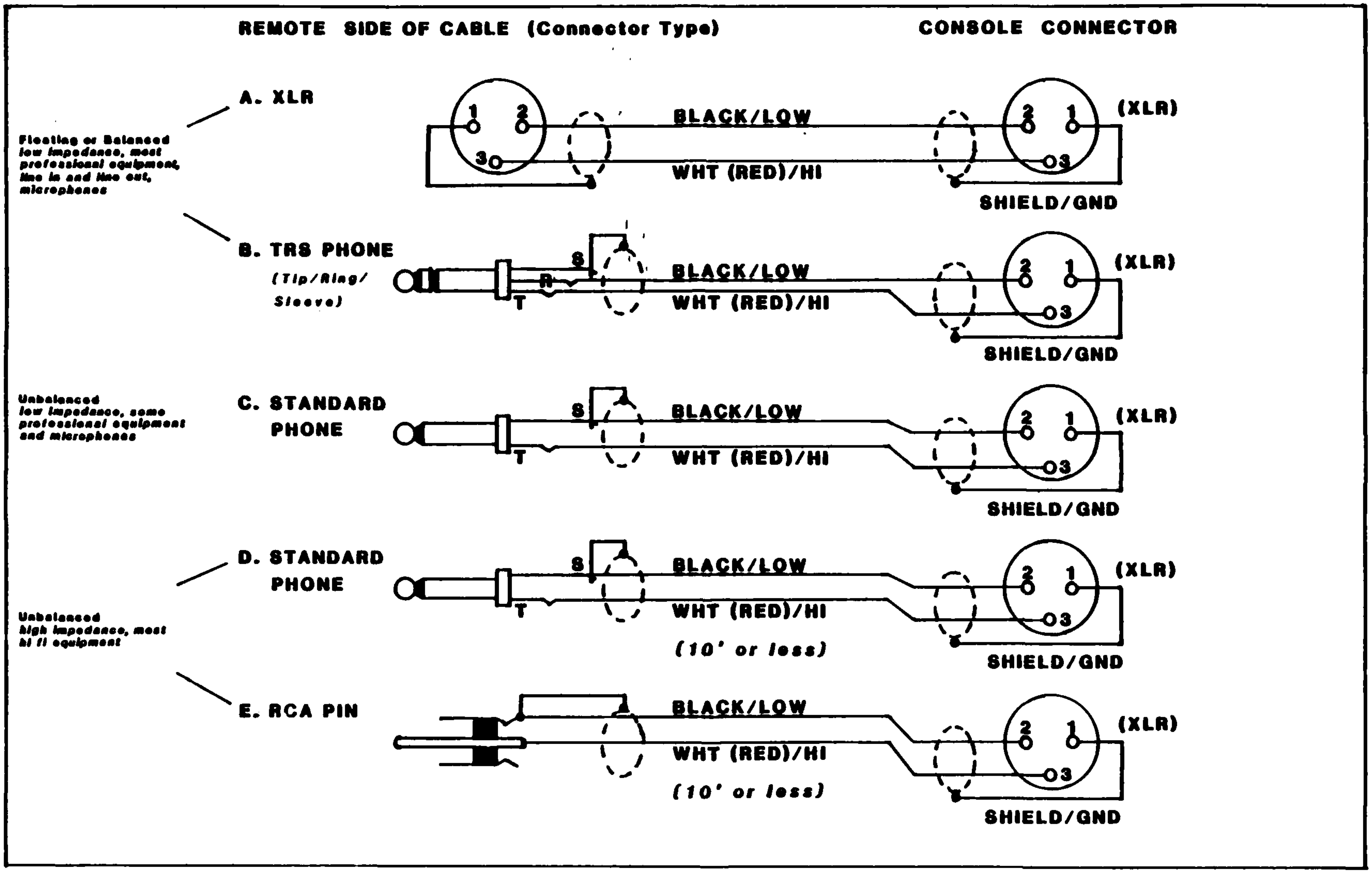


Figure 2. Connector Wiring Standard (23:4; 27:--)

## Chapter Five

## SPEAKER COVERAGE

Placement of reinforced sound requires much greater attention than time usually affords. Considering acoustical engineers devote much effort to building design and still encounter difficulties, it is absurd to think that a touring group, such as an Air Force band, could even come close to respectable, reinforced sound (12:110-112; 13:130; 17:133). The results, however, are excellent and perhaps can be refined with an understanding of the basic peculiarities of sound and speakers.

### SPEAKERS HAVE SPECIFIC LIMITATIONS

Instead of doing what the operator would like it to, a speaker does only what its design allows it to do. Only certain "geographic" territory can be handled by each speaker, and if all of the audience does not fit into that geography, then more speakers are required to do the job (22:2). High frequencies are very directional by nature (2:203; 19:60). That is, if they are projected in a specific funnel of sound, a listener outside that funnel will not hear all of those frequencies (3:Ch 9; 22:2-4). It is much the same as the loss of presence the listener experiences when moving into the next room from the home stereo. Contrarily, low frequencies are less directional, and tend to travel in a broader manner (2:114; 22:3). These characteristics are critical factors to understand when trying to get the sound to the audience.

### PUTTING THE SOUND WHERE IT'S NEEDED

If each high frequency horn had a range finder on it, the operator would be able to see the audience which will be able to hear those highs. Most horns have a spread or zone which is expressed in angles: 60° x 40°, 90° x 40°, 120° x 40°, 40° x 20°, etc. (22:3). The first number represents the horizontal coverage of the horn, the second, the vertical (16:27). "Looking" through the horn, then, would enable the operator to see how wide and how high a coverage exists.

Probably the most common problem is to reach both those people in the front rows of the auditorium as well as those in the last seat of the balcony (22:4). If they cannot all be "seen" by the speaker, then additional speakers

will have to be used to reach everyone (6:513-514). The difference between being in or out of the speaker coverage is so dramatic that it can be easily sensed by walking around the auditorium while pink noise is being generated through the systems. In certain buildings, height is really called for to effectively reach everyone (6:517). "Flying" the system above the band might be the ideal solution (13:130), but is an impossibility with Air Force band resources. Stacking the speakers, then, becomes the best compromise, with horns aimed at both the orchestra section as well as the balcony (22:13). Stacking will usually achieve the height to protect those seated in front.

## CONSIDER THE PEOPLE UP FRONT

The person in the back row deserves to hear things clearly, but not at the risk of parting the hair of those up front (22:4). Sound pressure or volume decreases inversely by the square of the distance from its source (5:606). This means that a sound at 8 feet will be one half as loud as the same sound at 4 feet (22:4). Therefore, to get enough sound to the last row, it can get uncomfortably loud up front. The solution is to aim hotter, more focused, speakers at the distant group and less powerful, more spread speakers at those people close by (16:28; 22:13). An operator must always remember that the volume he hears in the middle of the audience is not the sound level everywhere in the hall. It pays to sample different seats to arrive as close as possible to a fairly even distribution of sound. Figures 3 and 4 will assist in understanding both sound pressure level (SPL-volume) dropoff as well as speaker aiming principles (22:13).

It is virtually impossible to find a universal configuration for speakers. Each performance location varies so drastically that the main tools for success must be flexibility with the system and the operator's solid basic knowledge of the capabilities of the equipment he is working with. Individual speaker specifications must be consulted for exact coverage and power parameters. The intent of this discussion is to provide a general foundation of ideas. Having addressed some of the main parts of the traveling sound reinforcement systems it would do well to consider some practices which can help keep this expensive apparatus working.

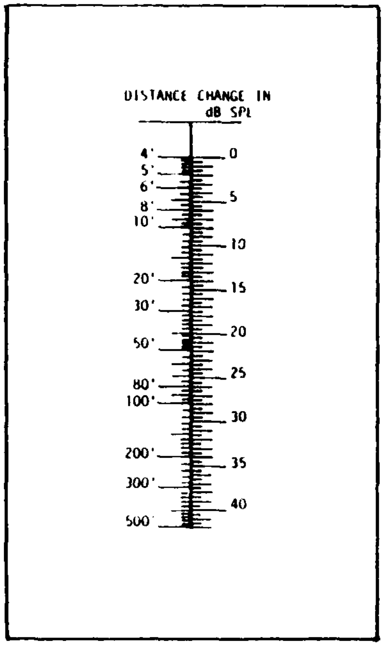


Figure 3. Volume Dropoff (22:4)

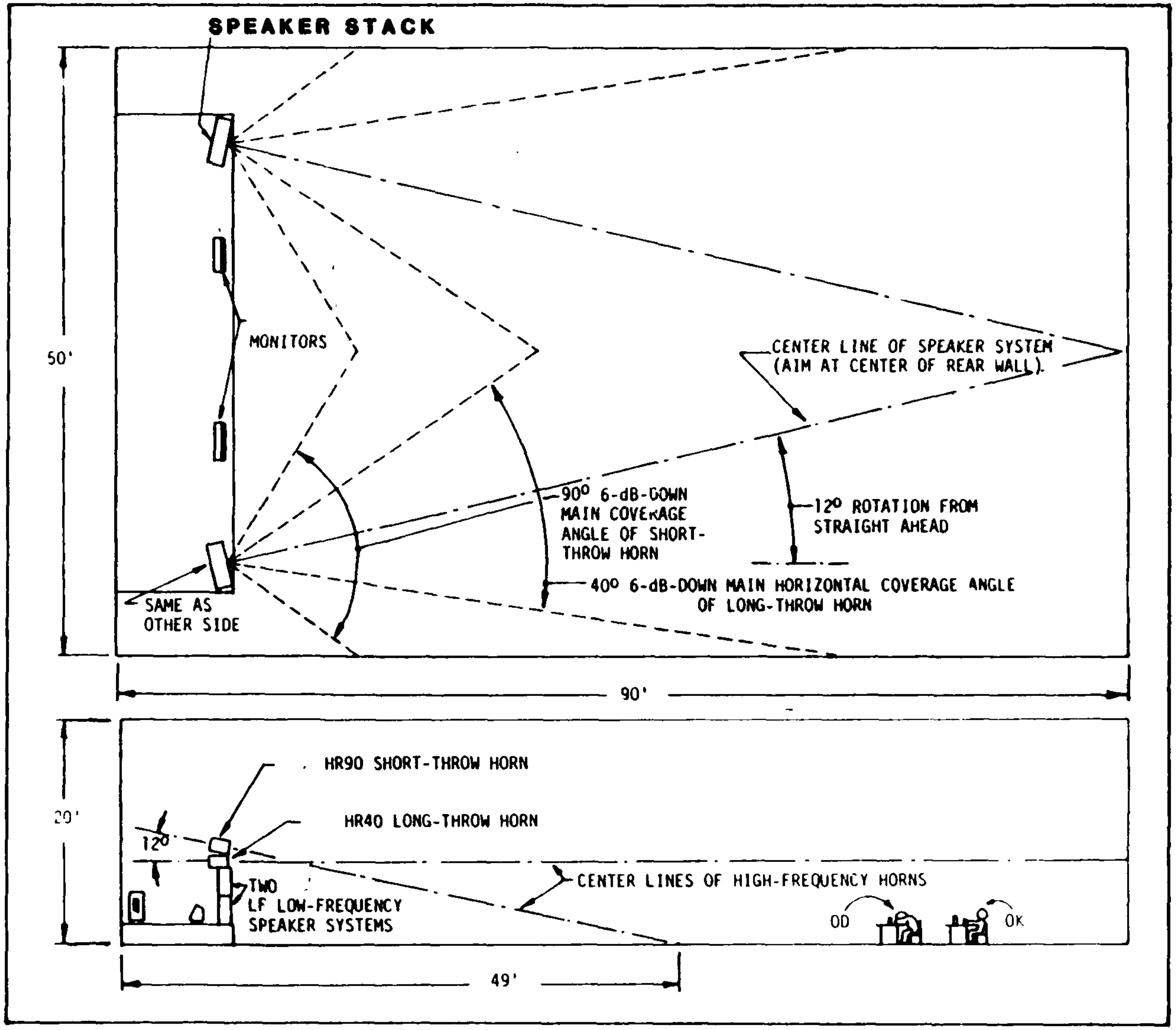


Figure 4. Speaker Aiming and Coverage (22:13-14)

Chapter Six

# PREVENTIVE TECHNIQUES

Many problems that crop up in performance could be avoided by exercising "preventive medicine" in maintenance and procedures. Although there is no program which assures 100 percent operability, absence of a conscious maintenance and policy program just about guarantees an unwanted surprise at the worst possible moment. Consequently it is advisable to establish some sort of timetable to anticipate the life expectancy of equipment and to project the timely replacement of components. In addition, a standard operating procedure should exist.

## PROGRAMMED REPLACEMENTS

The necessity for replacement of some items is obvious, however, there are a few which seem to go too long before action is taken. In these instances, at least, it is wise to program regular refurbishing and replacement. Personal observation by the author calls the reader's attention to a few items as a minimum.

Cables of any sort tend to deteriorate by constant use. This is especially true of mic lines which suffer from much bending and being walked on. Snakes similarly fall into this category. They should be replaced before they begin to rapidly disintegrate internally. Along with cables go connectors. With constant use they become worn. They, too, should be replaced prior to failing in public.

Two non-electrical items that take a royal beating are mic stands and travel cases. A rotten-looking mic stand or one which does not function properly should disappear. Professionalism and image are at risk here. On the other hand, travel cases play the important role of protecting equipment from damage. Their being in good repair is directly related to their effectiveness as gear is trucked countless miles each year. The investment in time to examine all of this equipment and to establish an organized approach to its care will add to ensuring continuous operating capability.

## DON'TS

This list of what not to do may spare an operator both gray hair and cardiac arrest. They have all been done.

Don't piggy back mic cords to make longer ones. The stress on the connectors will one day cause the connectors to come apart leaving a vocalist with an open mouth and no sound.

Don't use unfamiliar mics and stands for vocalists. It is hard enough to remember what the words are without having to figure out how to get the mic off the stand.

Don't use one power source only. Dividing up the load will avoid losing everything during a surge in sound and power. Losing everything means it gets real quiet.

Don't tie into a dimmer outlet. First off, it will put noise in the sound system. Secondly, it may destroy the equipment.

Don't tie into an outlet without a ground. Hum will probably exist in the system. In addition, mic users or electronic instrument players may be electrically tingled.

Don't use inadequate power cords. Both equipment operation and safety are factors here.

Don't leave the gain or volume up when checking out a malfunction. When the problem is found, the resulting feedback could mean a substantial investment in speakers.

Don't tape mic cords to floor or stands. Performers need to have the freedom to move around without being stuck to the stand.

Don't twist cables unnecessarily during setup and tear down. Cable life is shortened with every bend.

Don't use solder with corrosive flux or acid core. It eats up wires and components. Use rosin core only (11:764).

Don'ts are clearly negative, although the results of adhering to them are positive. Adding, now, on the positive side of things to watch for, these procedures will also contribute to a smoother, long-term operation.

## DO'S

The following "do's" may generally make for some brighter days.

Do tape mic cables to the front, top of the stage. The day the mic cord comes out of the mic, the performer is not going to want to chase the cord as it is being pulled into the orchestra pit by its own weight. Being taped, the cord will stay on stage.

Do tighten set screws in mics and XLR connectors on a regular basis. They will otherwise fall apart on stage.

Do check each speaker component up close for operation each performance. From the mixing board the operator frequently can't tell whether all parts of the system are working.

Do mark, repair or replace anything questionable immediately. It is better to fix it now than to wait until tomorrow. Something else may break tomorrow.

There are undoubtedly many other do's and don'ts that could be discussed. This small list, however, should at least make up a nucleus of procedures around which to build a complete program. The following chapter will elaborate on some common problems that arise when the heat is on, time is running out, the audience is arriving, and the darn system is misbehaving.

## Chapter Seven

## MAKING IT WORK ON THE JOB-
## TROUBLESHOOTING ON THE SPOT

### CRITICAL ASSESSMENT OF TIME

When time is short and things are not working right, the operator must reckon with reality. The number one objective is to make the system work on time. To do this sanely, he must first assess the time constraints quickly. Does enough time exist to identify and repair what might be wrong? If not, then the immediate option should be to replace the suspected component with a backup, then worry about repair.

### REDUNDANCY: FIRST RESORT

Just as in aircraft, redundant systems in sound can ensure the job gets done. Spares should always be handy on the road (20:35). Experience has shown that they will eventually be used (20:35). If the sound board malfunctions, the spare, perhaps smaller, can be substituted (20:35). This is advocated for any critical component, that is, any single component which has the potential for shutting down the show: sound board, power amp, cables, crossover network, speaker driver and fuses (20:35). First priority is to make the system work (20:34). Repairs can be made after the performance. Some problems, however, are simple to fix and rather common.

### MOST COMMON CAUSES OF FAILURE

This group of errors tends to be common and mostly due to oversight during setup.

Power amps not turned on or up
Mics plugged into wrong inputs
Speaker lines mismatched
Crossover or other component in line not on
Snake connectors not secure
Bad mic line (cable)
Bad snake line
Input off at sound board

In most cases, standardization of procedure can solve a recurring problem. While these are common problems, they still have to be found. Understanding how to trace the path of the signal will assist in isolating the problem.

## TRACING A SIGNAL

Following a signal through a sound system is a very logical process, rather like water going through a pipeline with valves along the pipe. There is usually a signal indicator on most pieces of equipment which shows the presence of a signal coming into or going out of that particular component. Consequently, the first thing to look for is whether or not a signal is showing up anywhere. If it is not at the board, then chances are it is pre-board, that is, either mic, mic cable, snake, connector, or plugged in wrong. If the signal is at the board, then simple step by step elimination will find the problem item. Either substitution or bypassing of a component may be necessary to narrow things down. In any case, jumping to hasty conclusions is an unwise practice since it usually only eats up valuable time.

Time, after all, is the constraint on producing good quality reinforced sound on the road. With time well assessed, a clear approach to procedures and a good knowledge of equipment operation, high caliber audio should be possible on a regular basis.

Chapter Eight

# CONCLUSION

When getting sound gear off the truck is the hardest part, sometimes it's difficult to remember that the main objective is to "wow" the audience with great sound. That, however, remains the principal objective of an Air Force band sound system as it does with any professional system. Making it work in the band environment, with personnel limitations, increases the challenge considerably. Nonetheless, it can, and has been done well and can continue to improve through education, training, and organization.

The facets of simple design, standardization, procedures, and planning are certainly not new ideas - but they are ideas that are easily overlooked when busy schedules vie for precious time. Ultimately, time can be saved, not to mention anxiety, by making the effort to standardize, organize and plan from the beginning. The payback is improved operation, a polished image and an impression which is left with the audience which conveys high standards and professionalism. In the contemporary world which is filled with sound, Air Force bands face overwhelming competition from the commercial market. This handbook is a small step toward assisting bandsmen in meeting that competition.

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